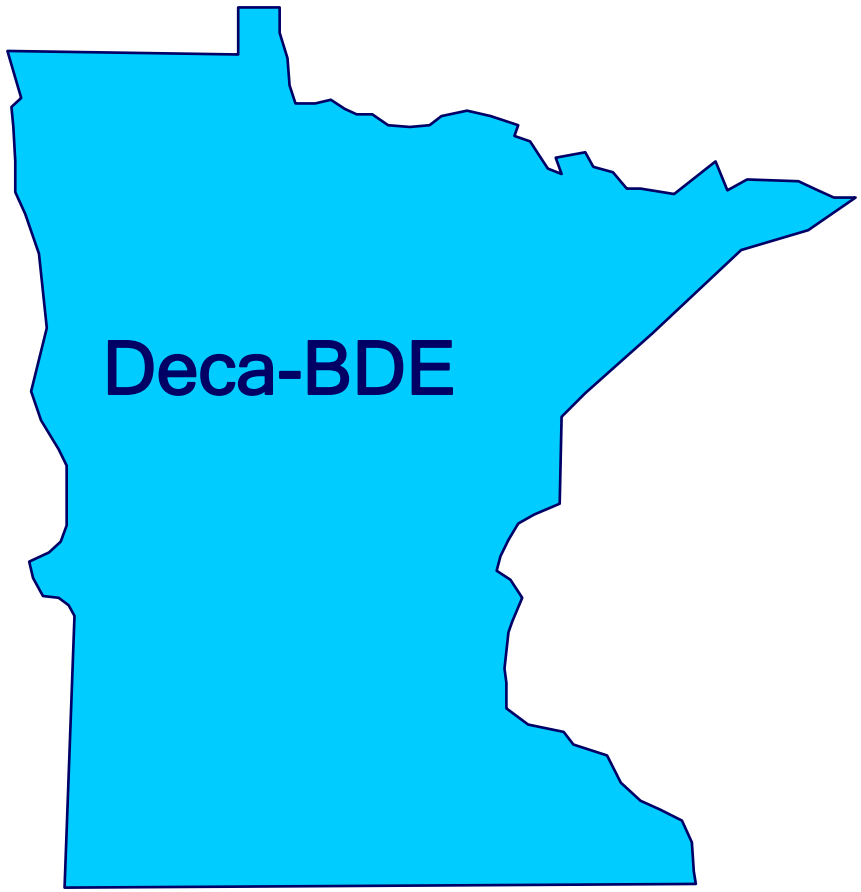
PBDEs: An Emerging Contaminant in MN



Environmental Release

1. PBDEs are released during its production and use, and from the use and disposal of final treated products.

2. Wastes containing PBDEs are incinerated, deposited in landfills, and discharged to WWTP or emitted into the atmosphere.

3. PBDE wastes buried in landfills can be leaked into ground water, surface water, air, soil and sediment.

4. PBDEs are discharge into the environment through WWTP effluents and sewage sludge.

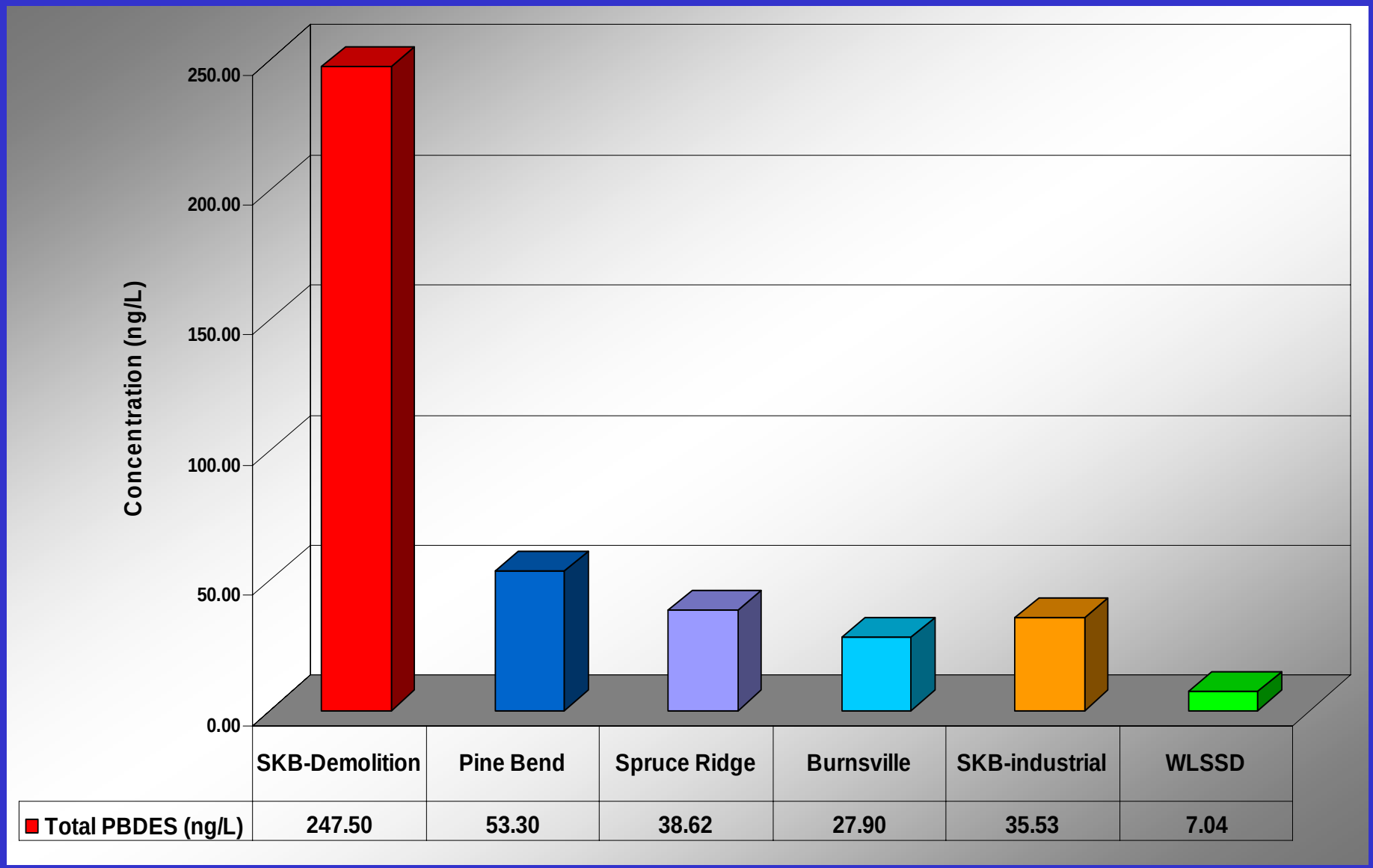
How are humans exposed?

- Primary route is believed to be through dietary exposure, which is also transported to offspring during nursing.
- Inhaling contaminated air and absorption through skin from furniture and other products.
- Household dust may be a potentially important pathway for human exposure.
- Concentrations found in humans are often similar to what is found in the treated consumer products, with a time delay assumed for transport of the contaminants from the source of release through the path of exposure to the exposed person.

PBDE Concentrations in Landfill Leachates (ng/L)

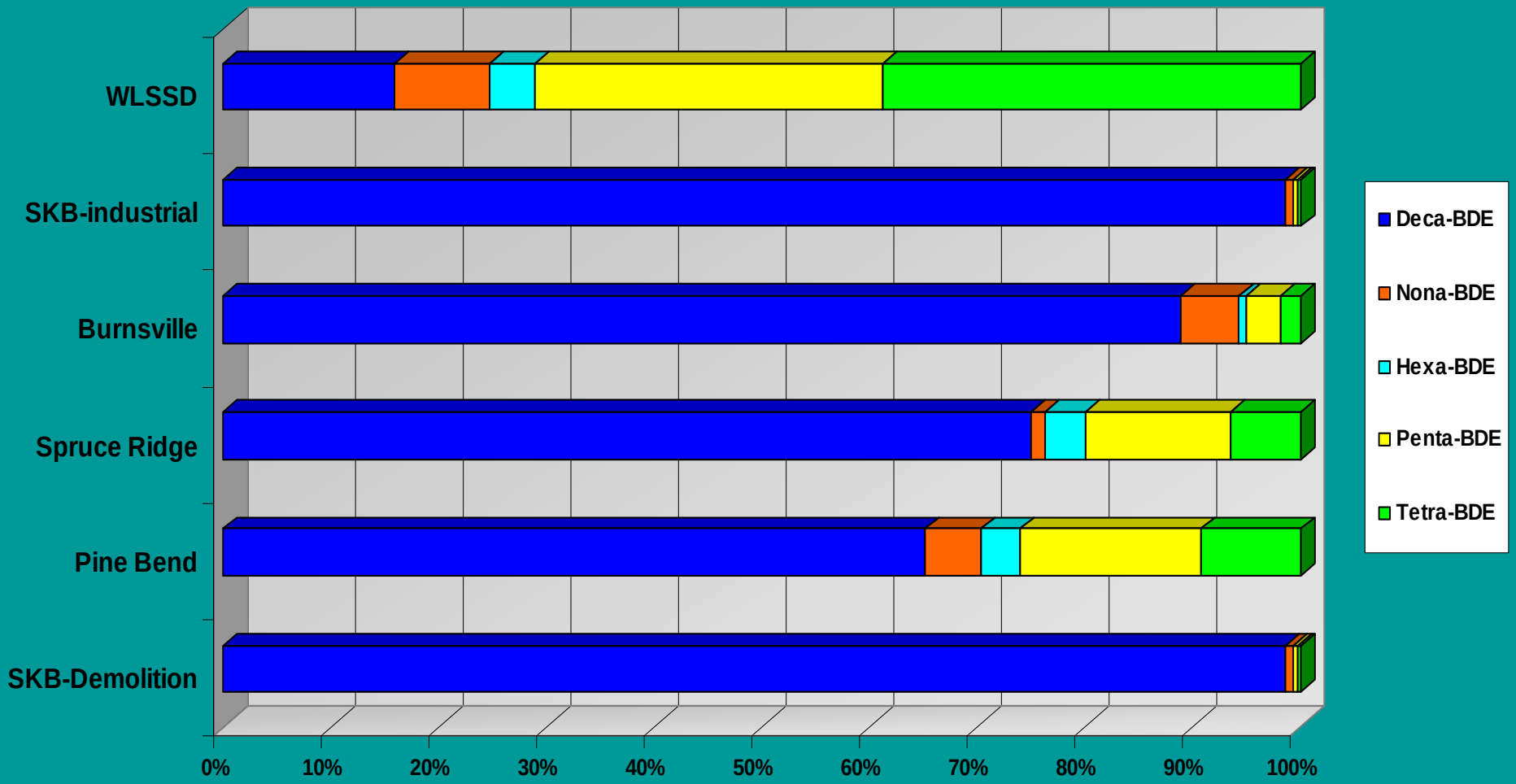
Type of Leachate	47	99	100	154	207	208	209	Total PBDEs
Demolition	.64	.95	.17	.11	.83	.57	243.84	**248.07**
Municipal	5.02	7.52	1.55	.87	1.51	.80	34.54	**56.50**
Municipal	2.59	4.24	.98	.68	.28	.17	28.54	**45.97**
Industrial	.18	.23	.05	.02	.14	.08	35.04	**35.91**
Municipal	.62	.85	.17	.09	.79	.45	24.74	**28.82**

Total PBDEs in Leachate of Different Types of Landfills



	SKB-Demolition	Pine Bend	Spruce Ridge	Burnsville	SKB-industrial	WLSSD
Total PBDES (ng/L)	247.50	53.30	38.62	27.90	35.53	7.04

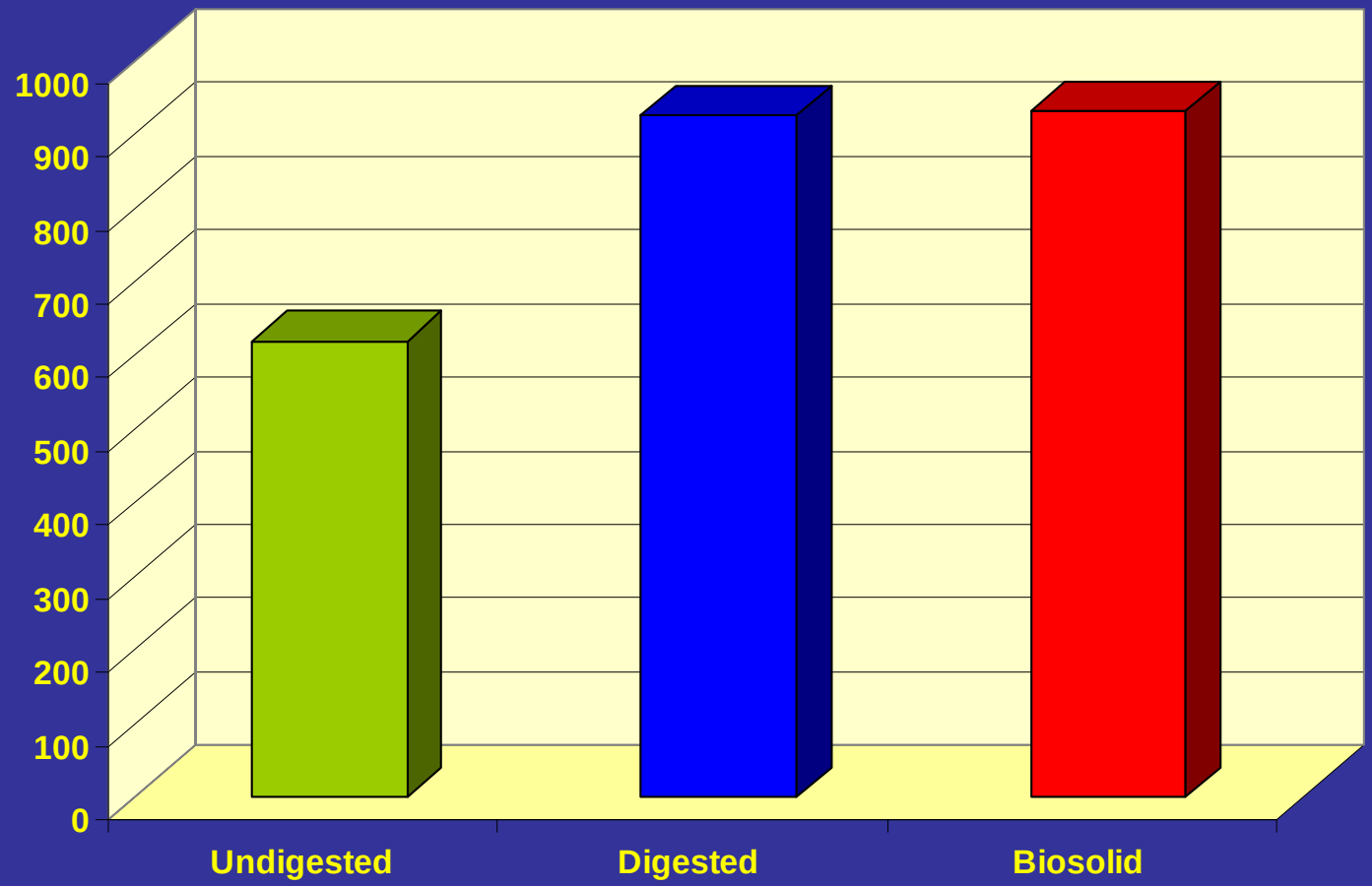
% Contribution of each Homologue to the Total PBDEs in Leachate of Different Types of Landfills



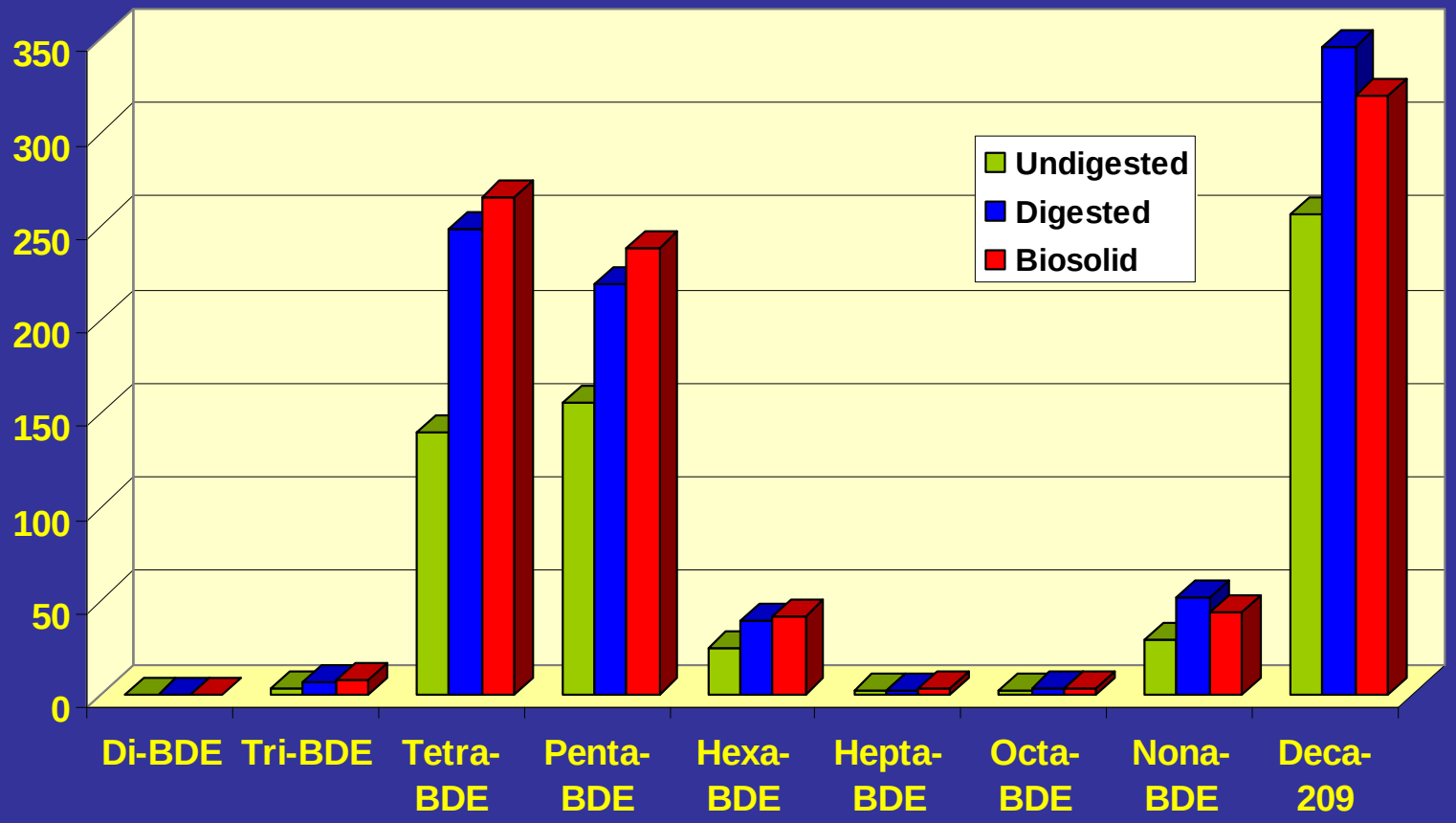
PBDE Concentrations in wastewater treatment plant Sludge (ng/L)

Sludge	47	99	100	153	154	183	207	209	Total PBDEs
Metro-primary	486	623	137	65	62	48	129	3,539	**5,305**
Metro-dewatered	853	1,030	178	76	70	48	145	2,180	**4,819**
WLSSD-raw	233	260	57	30	24	5	3	237	**889**
WLSSD-final	475	519	100	48	39	10	6	431	**1,732**

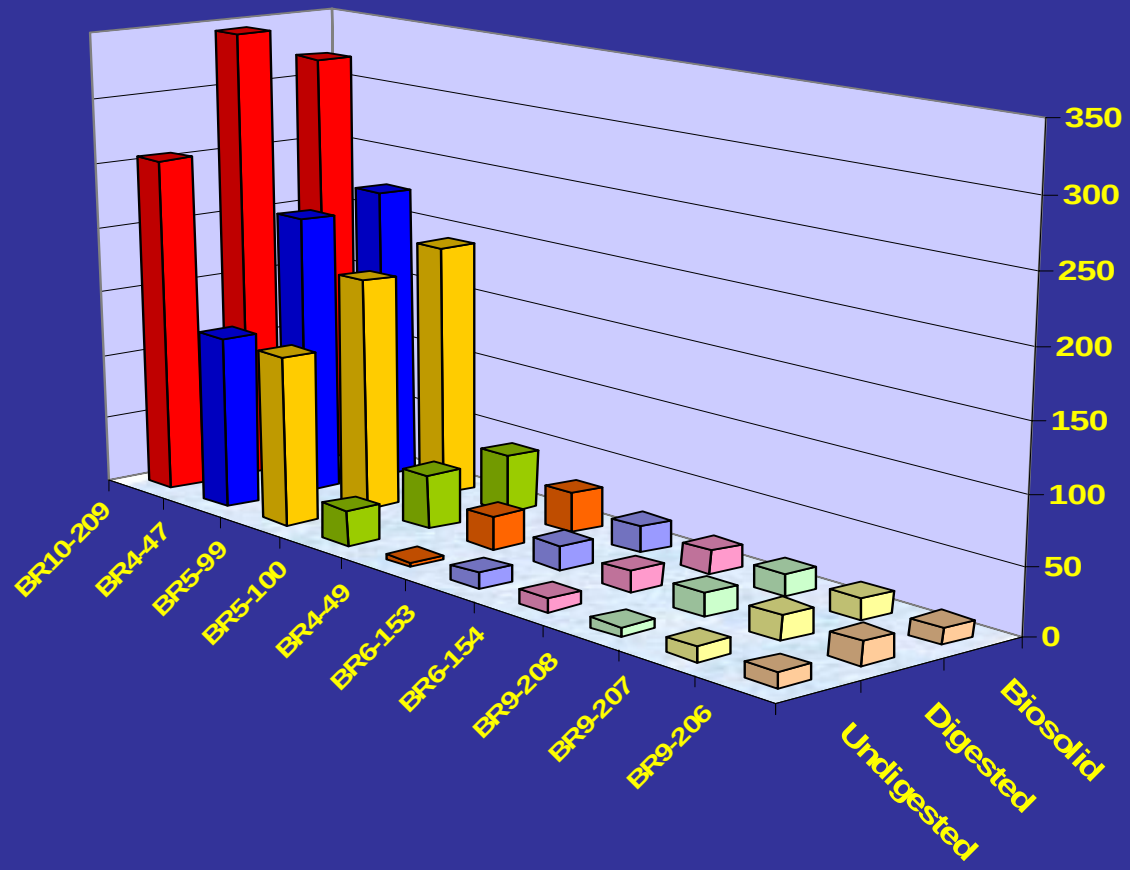
Total PBDEs in WWTP Sludge
(ng/g dry wt)



PBDE Homologues in WWTP Sludge
(ng/g dry wt)



Major PBDE Congeners in WWTP Sludge
(ng/g dry wt)



PBDEs:
Will Our Sludge Burn

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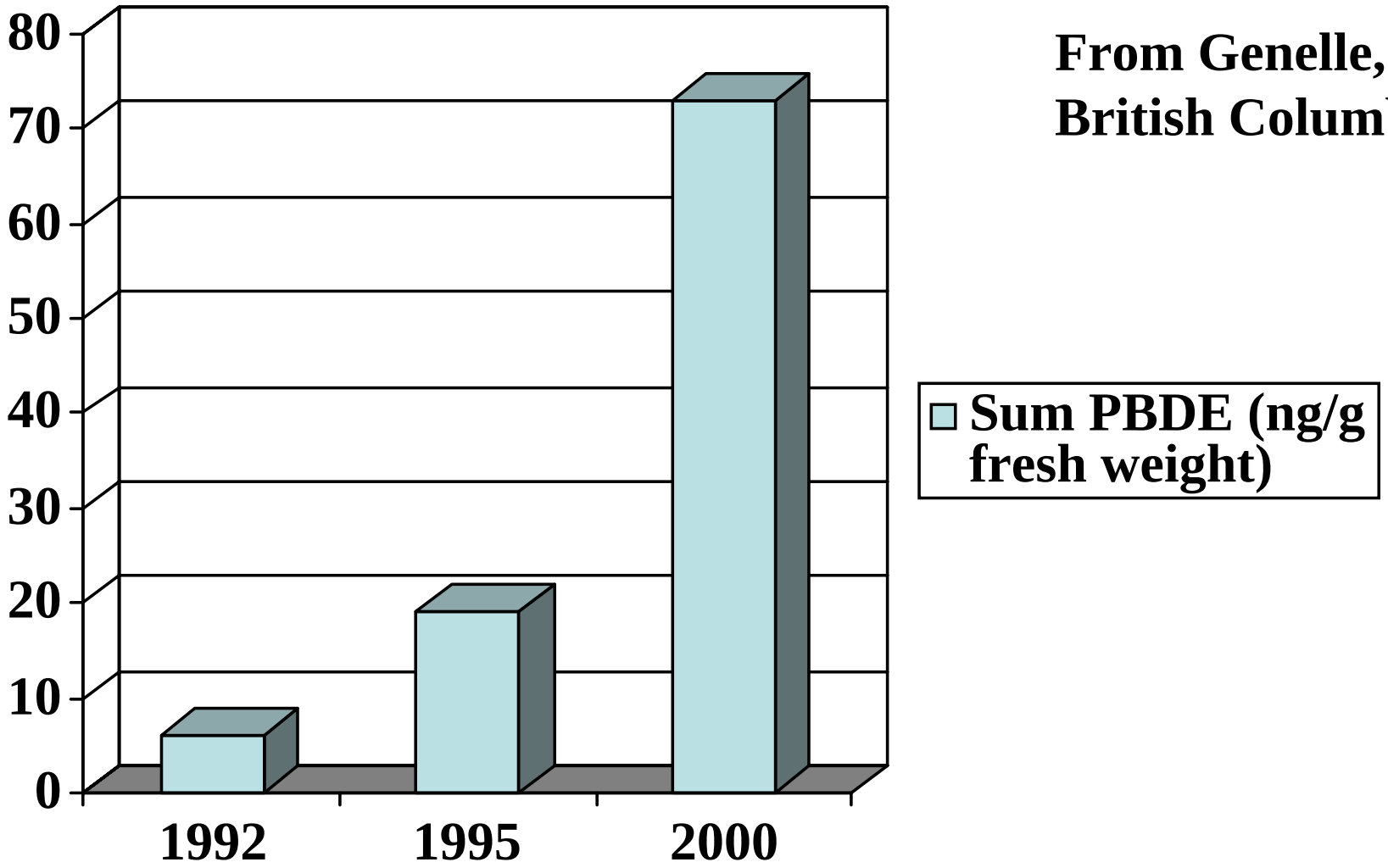
PBDEs in Columbia River Whitefish



Rayne *et al.* (2003) Environ Sci Technol 37(13):2847-54.

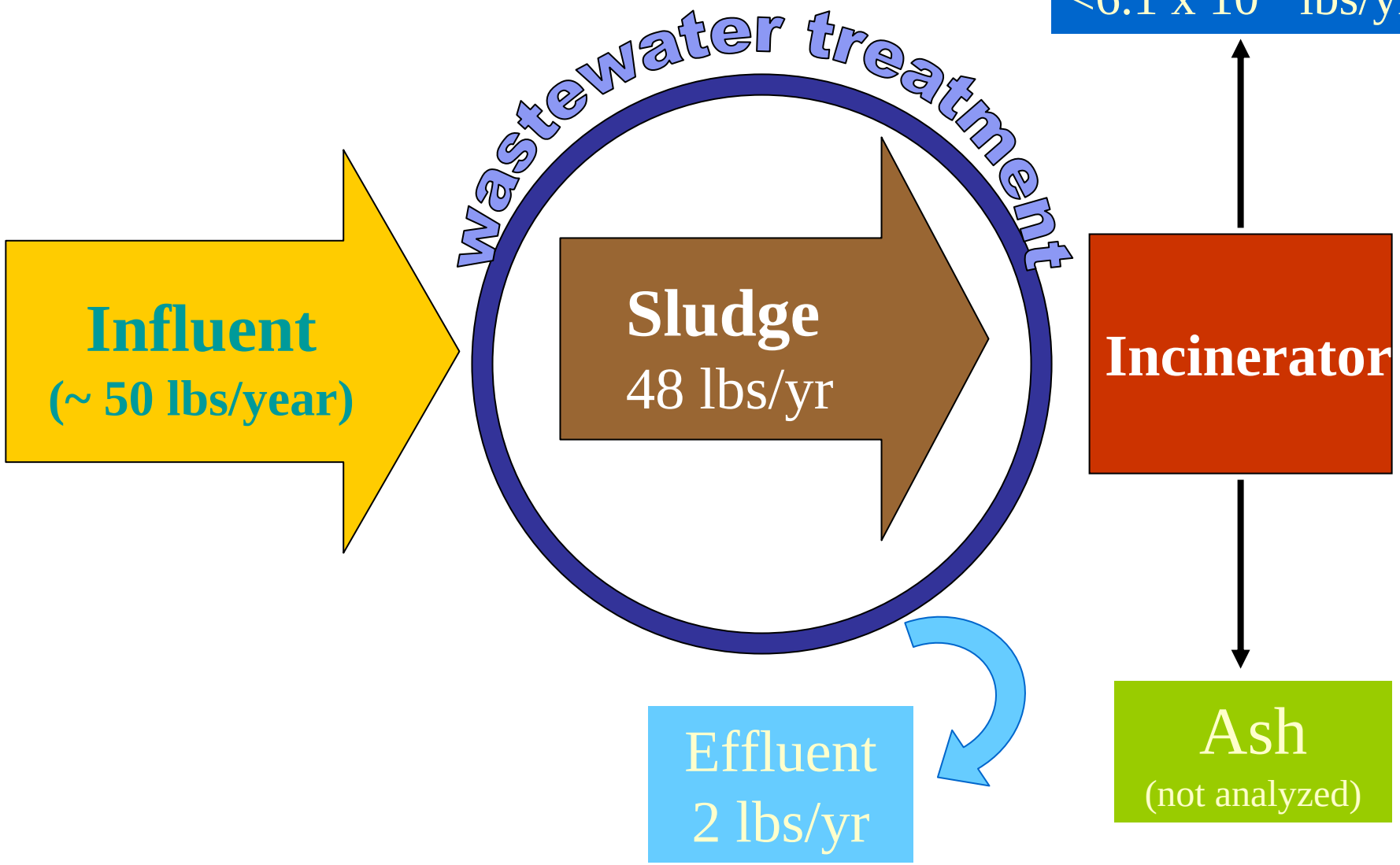
Palo Alto's Study

- August 2002
- 3 days of sampling, composite samples
- Effluent and biosolids tested for 41 PBDE congeners
- Incinerator emissions tested for brominated furans and brominated dioxins
- Concentration levels at ppt (ng/L or ng/kg)

Palo Alto's Loading Data

- 96% of PBDEs sorb onto biosolids
- 4% of PBDEs are discharged to Bay
- Incinerator transforms PBDEs to brominated furans and brominated dioxins
- Air pollution control device destroys 99.9% of dioxins and furans

Fate of PBDEs
(wastewater treatment plant)



Overview of Results

- PBDE concentration in US Sludge is 10 to 100x greater than Europe
- Deca-BDE largest concentration in biosolids (~1,183 ppb)
  - Renewed concern over Deca (new data on debromination by UV and biota)
- BDE-99 (part of penta-formulation) largest concentration in effluent (~0.01 ppb)

Potential Sources to POTW

- Unclear direct source since it is found everywhere in the environment
- Some possible sources include:
  - Rinsing of cleaning rags
  - Carpet cleaning
  - Laundry and shower gray water
  - Human waste

Polybrominated Diphenyl Ether (PBDE) Flame Retardants in US Human Blood, Milk, Food, and Environmental Samples

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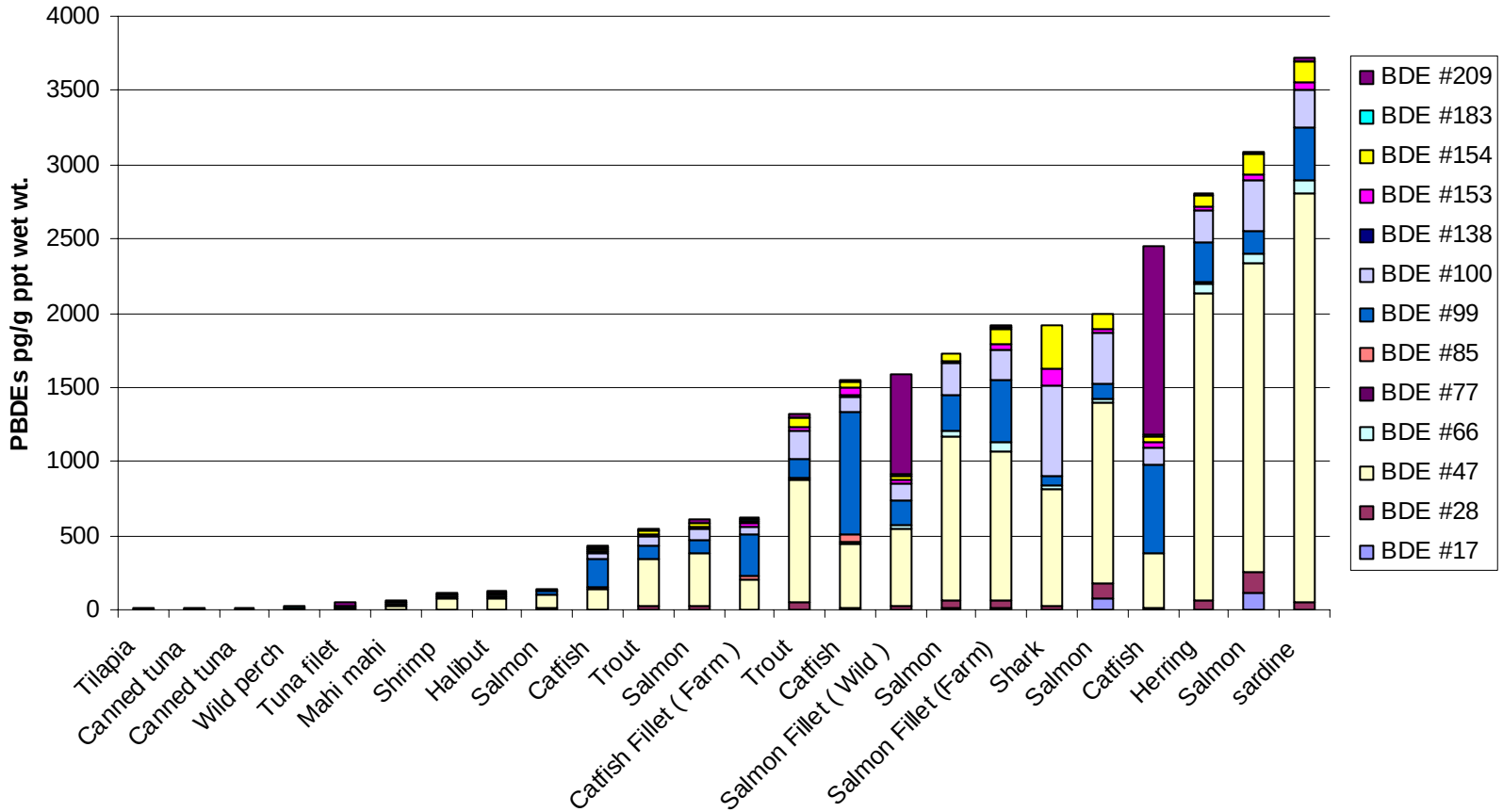
Market basket survey of US food, 2003

- 62 food samples purchased from 3 Dallas, Texas supermarket chains in 2003.
- Measured 13 individual PBDE congeners.

	Sum PBDEs Median (ppt, ww)
Fish N=24	616
Meat N=18	190
Dairy N=15	32.2
Miscellaneous N=5	84-2835

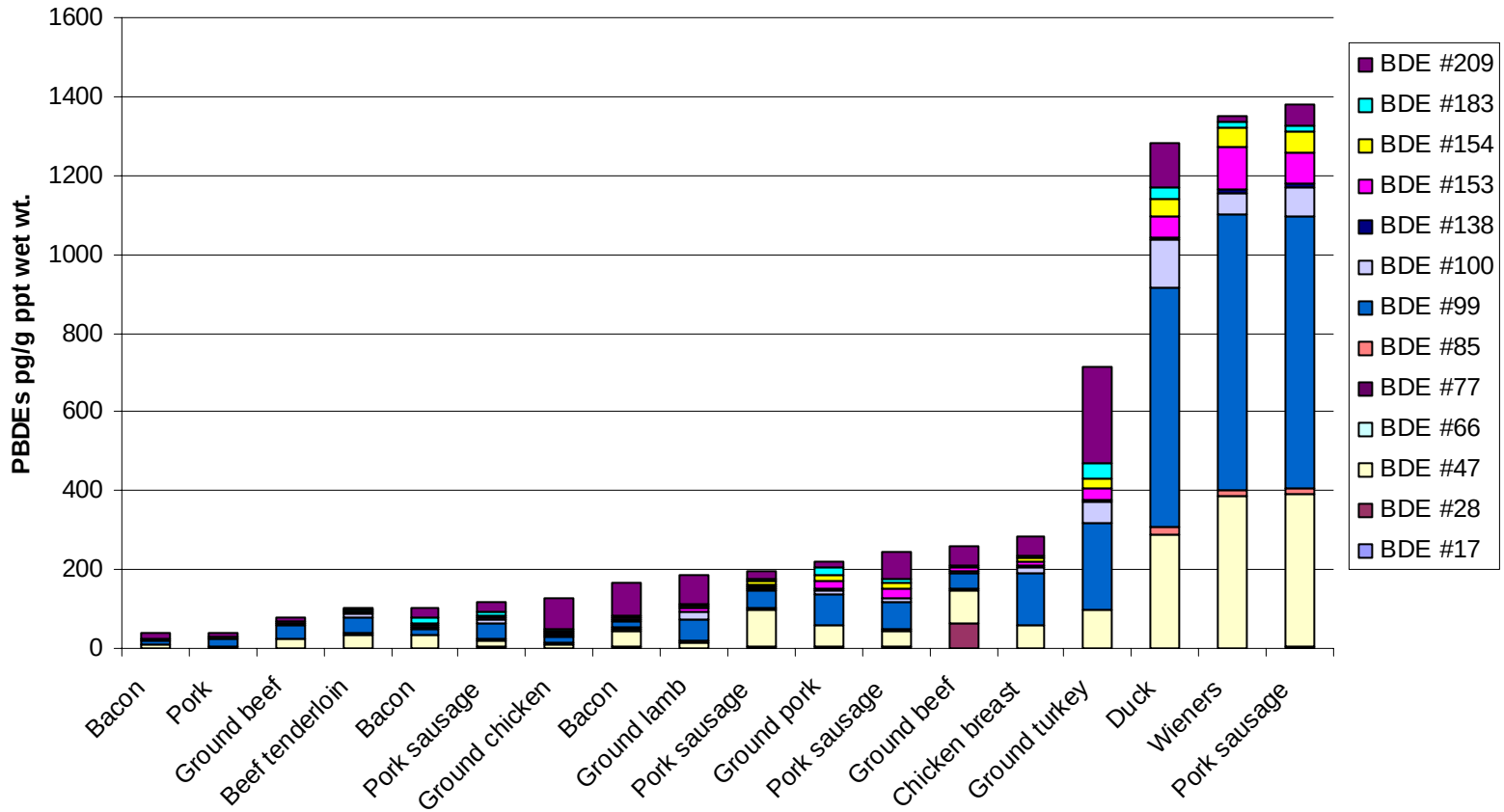
PBDE congener levels of fish in the USA

Fish n=24. Range: 11 - 3726 pg/g. Mean: 1120 pg/g. Median: 616 pg/g.



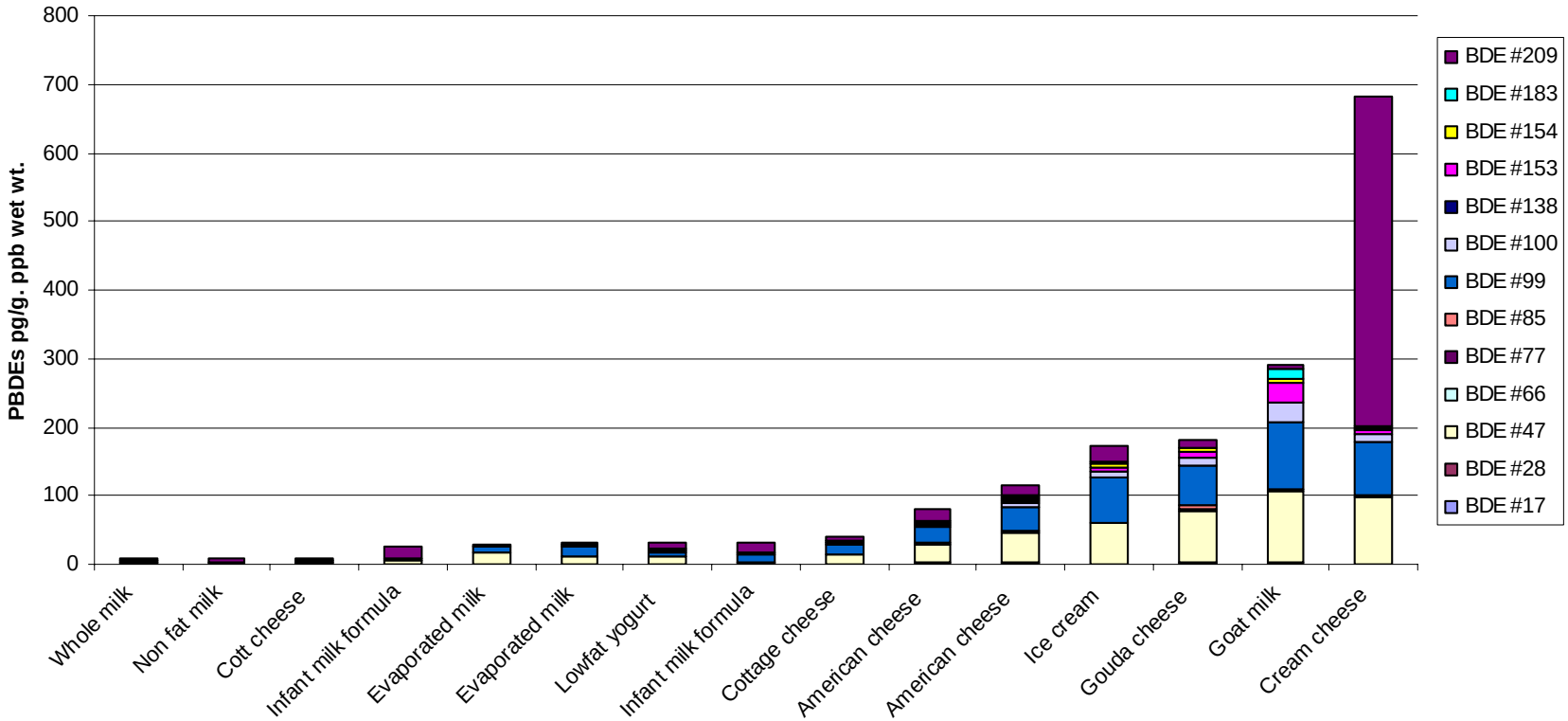
PBDE congener levels of meat in the USA

Meat n=18. range: 39 - 1378 pg/g. Mean: 383 pg/g. Median: 190 pg/g.

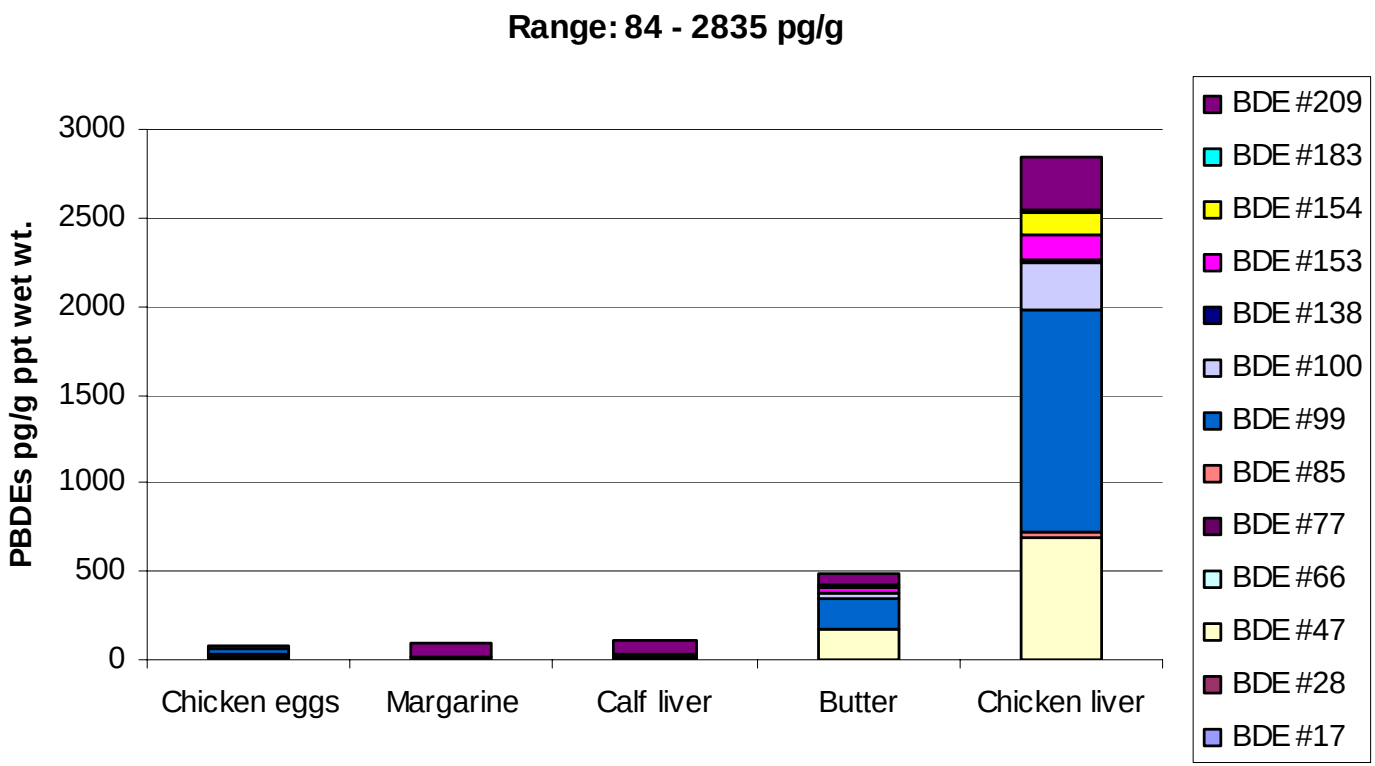


PBDE congener levels of dairy products in the USA

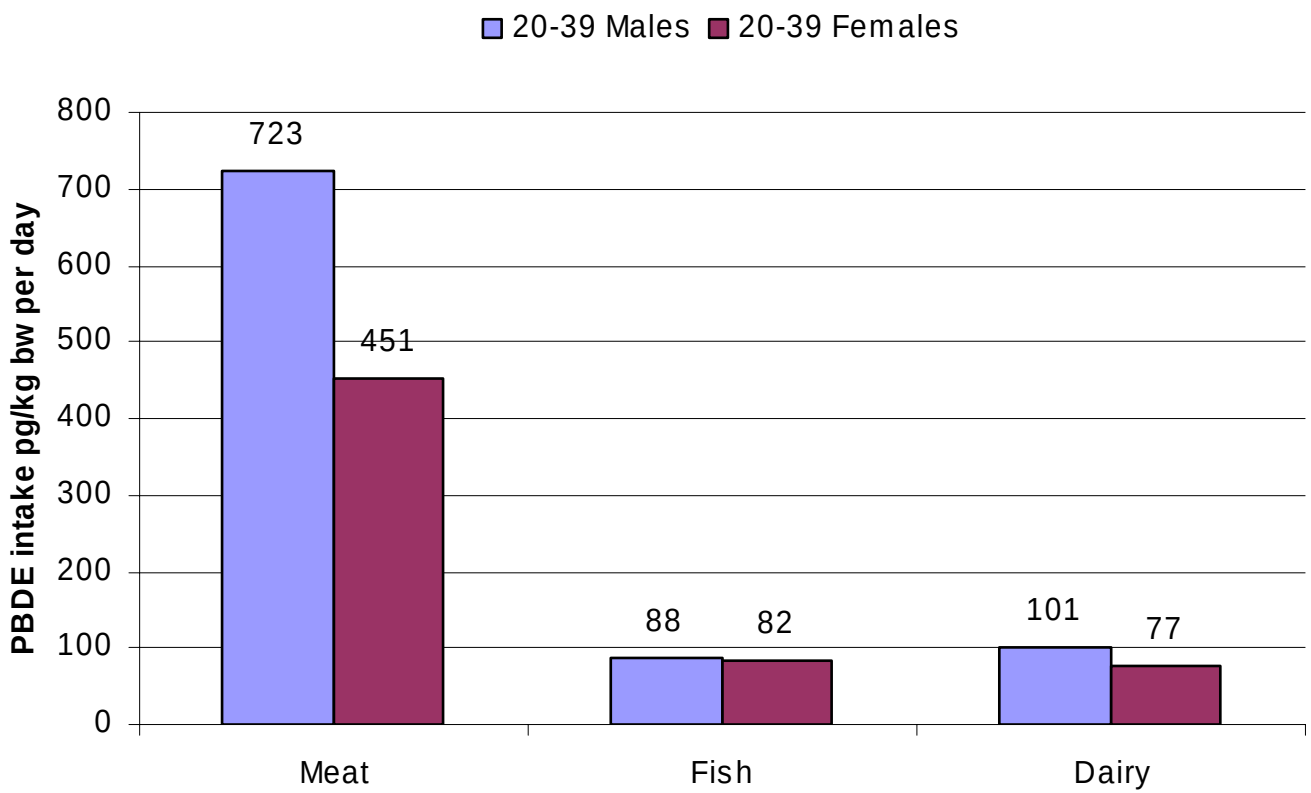
Dairy n=15. range: 7.9 - 683 pg/g. Mean: 116 pg/g. Median: 32.2 pg/g



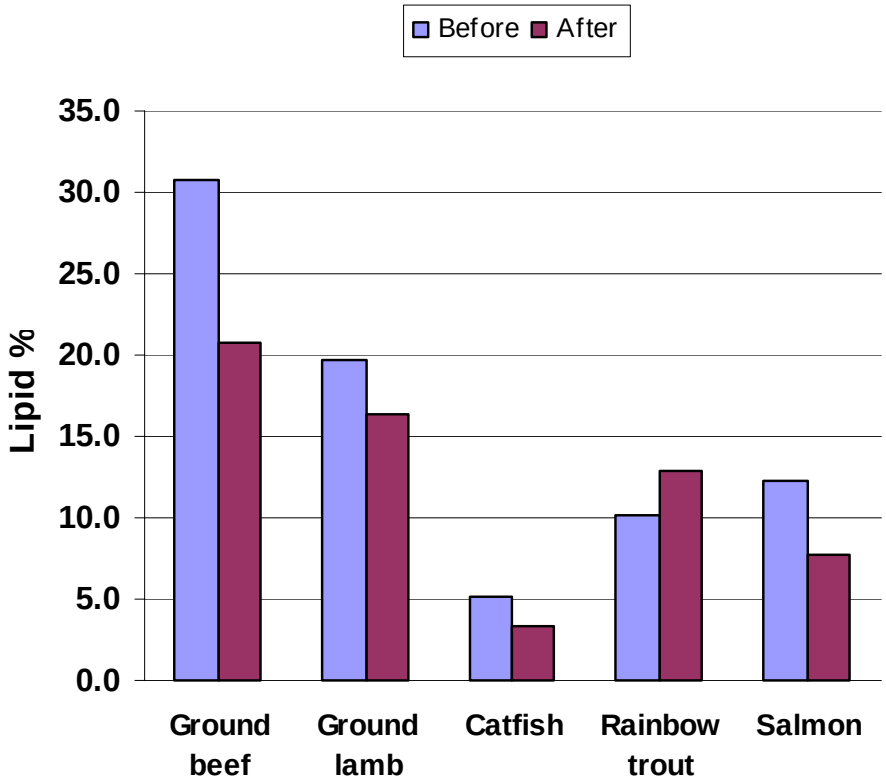
PBDE congener levels and profiles of individual miscellaneous products in the USA.

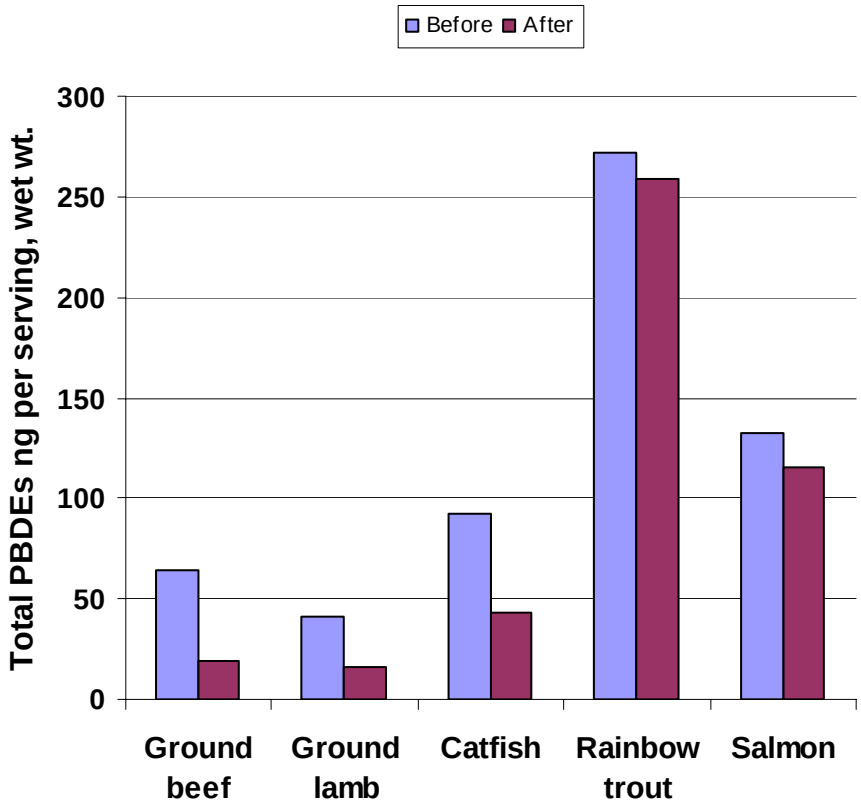


Daily U.S. adult PBDE intake estimate



Effect of cooking





Analysis of Chemical Contaminant Levels in Store-Bought Fish from Washington State

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Washington State Department of Health

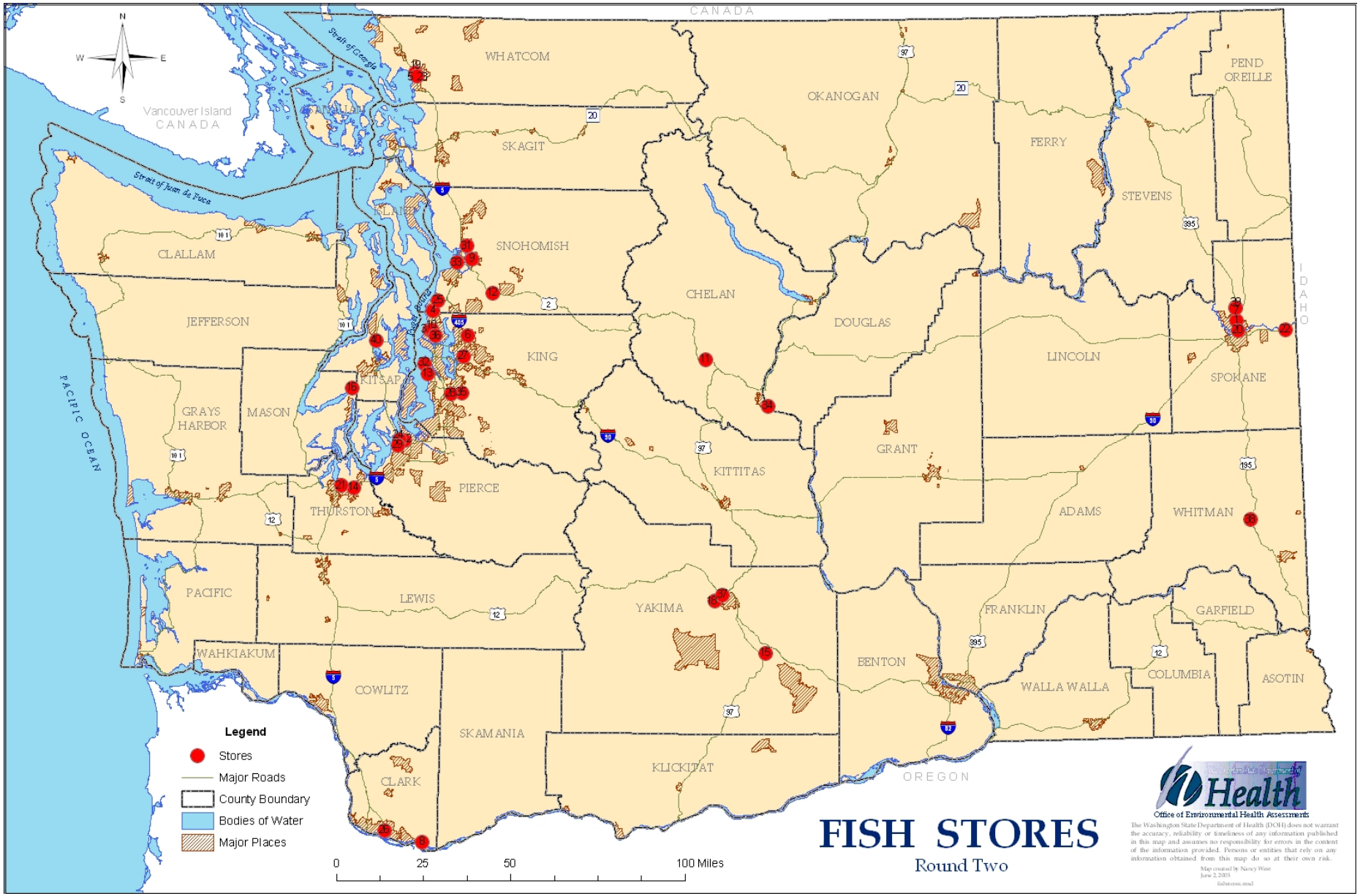
Sampling Fresh and Frozen Fish

- Species chosen based on frequency of consumption and expected contaminant levels
  - Catfish
  - Cod
  - Flounder
  - Halibut
  - Red Snapper
  - Pollack
  - Salmon
  - Tuna (canned white & light)
  - Tuna steaks, carp

EPA 1996, FDA 1994

Washington State Department of Health

Location of Grocery Stores



Mercury Results

Species	Mean (ppb)	Range (ppb)	N	Det. Freq. (%)
Catfish	8.5	8.5 – 8.5	23	0
Pollack	9.1	8.5 – 22	24	4
Salmon	71	8.5 – 150	17	94
Cod	115	34 – 391	33	100
Tuna – light	126	8.5 – 1160	55	96
Flounder	147	28 – 303	18	100
Halibut	215	20 – 1260	30	100
Red Snapper	223	21 – 674	27	100
Tuna – white	357	52 – 912	63	100

ND = ½ DL

PBDE Results

Species	Mean (ppb)	Range (ppb)	N	Det. Freq. (%)
Pollack	2.0	1.4 – 3.8	23	0
Flounder	2.0	1.2 – 3.7	19	16
Halibut	2.1	1.2 – 7.2	29	41
Red Snapper	2.3	0.8 – 3.9	27	56
Tuna – light	2.4	1.5 – 6.5	20	5
Tuna – white	2.4	1.6 – 4.5	20	15
Cod	2.5	0.8 – 9.8	33	12
Catfish	3.3	1.4 – 10.1	24	25
Salmon	5.3	1.5 – 15.7	17	88

ND = ½ DL

Meal Recommendation Calculations

- Meals per month = $\frac{\text{RfD x BW x CF}}{\text{MS x Conc.}}$

Parameter	Value	Units
RfD - Reference Dose		
PCBs	2.0E-5	mg/kg-day
Mercury	1.0E-4	
PBDEs	NA	
CF - Conversion Factor	30.4	days/month
BW - Body Weight	70 (adult)	kg
MS - Meal Size	0.227	kg/meal
Conc. – Concentration	mean	mg/kg

Drivers of Meal Recommendations

Species	Hg meals per month	PCB meals per month
Catfish	unlimited	16
Cod	8	unlimited
Flounder	8	unlimited
Halibut	4	16
Pollack	unlimited	unlimited
Red Snapper	4	16
Salmon	16	8
Light Tuna	8	16 (unlimited)
White Tuna	2 (4)	16 (unlimited)

value in parenthesis based on 6 oz.(1 can) meal size

Conclusions

- Mercury was most frequently detected
  - 7 out of 9 species had det. freq. > 90%
  - Canned white tuna had highest mean (357 ppb)
  - Hg levels resulted in more restrictive meal recommendations in 6 out of 9 species
- PCBs – only halibut, red snapper, & salmon had det. freq. >10%
  - Salmon had highest mean (32 ppb)
  - PCB levels more restrictive in catfish and salmon
- Levels of PBDEs measured in fish sold in Washington State grocery stores are similar to levels previously reported
  - BDE-47 most frequently detected in fish

Washington State Department of Health

BRFSS Fish Consumption Questions

- How often do you eat canned tuna?
- In the past 30 days, how often did you eat either fresh or frozen store bought fish, including fish items such as fish sticks?
- Not counting shellfish, please tell me all the types of FRESH FISH you ate in the past 30 days (*purchased at a grocery store or fish market*).

Washington State Department of Health

PBDE Results

Species	Sample Size	Det. Freq. (%)	Mean (ppb)
Pollack	23	0	2.0
Flounder	19	16	2.0
Halibut	29	41	2.1
Red Snapper	27	56	2.3
Tuna – light	20	5	2.4
Tuna – white	20	15	2.4
Cod	33	12	2.5
Catfish	24	25	3.3
Salmon	17	88	5.3

Heart HealthMarch 2006

American Heart Association Says Children Should Eat Fish

Two leading professional organizations support new nutrition guidelines for children. The American Heart Association (AHA) and the American Academy of Pediatrics recognize that the health problems of today's children—overweight and obesity, increasing occurrence of diabetes, poor food habits, too little exercise—begin in childhood. These groups urge physicians to acquaint their patients with the recently revised AHA dietary recommendations for children. Improving children's eating habits helps establish long-lasting food habits that discourage the development of heart disease, high blood pressure, diabetes, and obesity.